



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : E21B 43/01, B63B 21/50	A1	(11) International Publication Number: WO 93/24733 (43) International Publication Date: 9 December 1993 (09.12.93)
--	----	---

(21) International Application Number: PCT/NO93/00082

(22) International Filing Date: 25 May 1993 (25.05.93)

(30) Priority data:
922044 25 May 1992 (25.05.92) NO

(71) Applicant (*for all designated States except US*): DEN NOR-SKE STATS OLJESELSKAP A.S. [NO/NO]; Postboks 300 Forus, N-4001 Stavanger (NO).

(72) Inventors; and

(75) Inventors/Applicants (for US only) : FJELL, Knut, Harry [NO/NO]; Leirmyrå, N-4362 Vigrestad (NO). OD-LAND, Jonas [NO/NO]; Austråttv. 7A, N-4300 Sandnes (NO).

(74) Agent: TANDBERGS PATENTKONTOR AS; Postboks 7085 H, N-0306 Oslo (NO).

(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

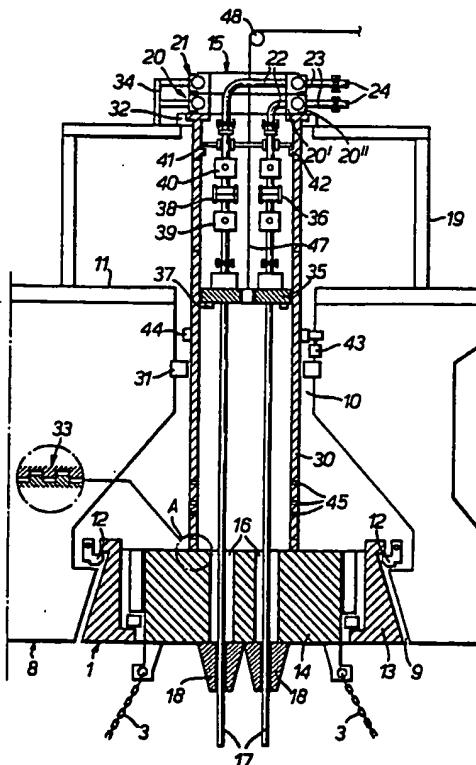
Published

*With international search report.
In English translation (filed in Norwegian).*

(54) Title: A SYSTEM FOR USE IN OFFSHORE PETROLEUM PRODUCTION

(57) Abstract

A system for use in offshore oil and gas production from production wells on the sea bed, comprising a submerged buoy (1) having an outer buoyancy member (13) which is arranged for introduction and releasable fastening in a submerged, downwardly open receiving space (9) in a vessel (8), and a central member (14) which is rotatably mounted in the outer member (13) and is anchored to the sea bed and is connected to at least one transfer line (17) extending from a respective production well up to the buoy, a shaft (10) extending between the receiving space (9) and the deck (11) of the vessel (8). A swivel unit (15) comprising inner and outer mutually rotatable swivel member (20', 20'') is arranged at deck level, and with the inner swivel member is rigidly connected to a holding cylinder (30) extending downwards through the shaft (10) and with its lower end being non-rotatably connected to the central member (14) of the buoy (1). The central member (14) of the buoy is provided with lead-through passages (16) for the topical number of transfer lines (17), so that these can be pulled up through the buoy and via the holding cylinder (30) up to the swivel unit (15), these lines (17) at their upper ends being arranged for connection with associated conduit connections (22) which are connected via the swivel unit (15) to a tube system (24) on the vessel (8).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SK	Slovak Republic
CI	Côte d'Ivoire	L.I.	Liechtenstein	SN	Senegal
CM	Cameroon	LK	Sri Lanka	SU	Soviet Union
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	MC	Monaco	TC	Togo
DE	Germany	MG	Madagascar	UA	Ukraine
DK	Denmark	ML	Mali	US	United States of America
ES	Spain	MN	Mongolia	VN	Viet Nam
FI	Finland				

A system for use in offshore petroleum production

The invention relates to a system for use in offshore oil and gas production from production wells on the sea bed, comprising a submerged buoy having an outer buoyancy member which is arranged for introduction and releasable fastening in a submerged, downwardly open receiving space in a vessel, and a central member which is rotatably mounted in the outer member and is anchored to the sea bed and is connected to at least one transfer line extending from a respective production well up to the buoy, a shaft extending between the receiving space and the deck of the vessel.

A system of the above-mentioned type, for use in buoy loading and unloading, is disclosed in the international patent application No. PCT/NO92/00054. In such systems the submerged buoy forms a collecting point for one or more flexible risers and umbilical cables from e.g. a production system at the sea bed or an oil-delivering conduit from a production unit. The buoy is adapted to be raised and fastened in the receiving space in the vessel in question, to establish a transport system for the petroleum products from said system to holds in the vessel.

When a buoy of the introductory stated type is secured in the receiving space in a vessel, the vessel is rigidly fastened to the outer buoyancy member of the buoy and is rotatable about the central member of the buoy which is anchored to the sea bed by means of a suitable mooring system. Thus, the buoy itself constitutes a turning body or turret about which the vessel is allowed to turn under the influence of wind, waves and water currents.

This buoy structure involves a number of substantial advantages in relation to previously known buoy loading systems. The central member of the buoy has a small diameter and a small mass, so that there is obtained a correspondingly small diameter of the turning body, i.e. the outer buoyancy member of the buoy, and therewith a small rotary mass and a small rotational resistance. Connection and disconnection between vessel and buoy can be carried out in a simple and quick manner, even in bad weather with relatively high waves. Further, the buoy may remain connected to the vessel in all weathers, a quick disconnection

being able to be carried out if a weather limitation should be exceeded.

In a vessel which is adapted for use with the buoy structure mentioned above, the receiving space and the shaft 5 arranged thereabove suitably are arranged in the bow portion of the vessel, as shown in the above-mentioned international patent application. This makes possible a relatively simple and cheap rebuilding of existing vessels for adaptation to such a buoy loading system, for use as shuttle tankers. The combination of 10 a submerged receiving space and a shaft which extends between the receiving space and the deck of the vessel, in addition makes possible a system giving a high security in operation and a small risk for contaminating spills.

For a further description of the buoy structure 15 mentioned above and of a vessel of the above-mentioned type, reference may also be made to the international patent applications Nos. PCT/NO92/00055 and PCT/NO92/00056.

As regards offshore oil and gas production by means of production vessels, there are known different solutions, i.a. of 20 the type which is based on a submerged bottom-anchored buoy and a receiving space arranged in the ship in the form of a moonpool which e.g. contains a turning cylinder or turret for reception and mounting of the buoy. It is common to the known systems that they are relatively expensive, mainly because of large dimensions 25 of the turning cylinder and the system as a whole. This results in that production vessels according to the prior art are not economically and practically usable in connection with minor or marginal oil fields. Thus, there is a need for simple mobile production solutions making possible an economic exploitation 30 also of smaller oil fields, especially with little gas, and with a production rate of up to 5000 m³ oil per day.

Thus, it is a main object of the invention to provide a system for use in offshore oil and gas production which makes possible an efficient and economic exploitation of e.g. smaller 35 or marginal oil fields, the inherent advantages of the introductory stated buoy loading system being utilized and retained.

The above-mentioned object is achieved with a system of the introductory stated type which, according to the invention,

is characterized in that it comprises a swivel unit which is arranged at deck level of the vessel and which comprises inner and outer mutually rotatable swivel members and with the inner swivel member is rigidly connected to a holding cylinder which extends downwards through the shaft and with its end is arranged for non-rotatable connection with the central member of the buoy, and that the central member of the buoy is provided with a lead-through means for the topical number of transfer lines, so that these can be pulled up through the buoy and inside of the holding cylinder up to the swivel unit, these lines at their upper ends being arranged for connection with associated conduit connections which are connected through the swivel unit to a tube system on the vessel.

A substantial advantage of the system according to the invention is that it gives reduced system dimensions because of the utilization of the special buoy which itself constitutes a turning body. This results in weight saving and a reduced equipment volume, which gives substantially reduced costs.

The system according to the invention requires minimum rebuilding of shuttle tankers for the introductory stated buoy loading system, for transition to production vessels. With such a production vessel seasonal operations will be possible, in addition to continuous production from marginal fields, and also test production. The vessel for example may be used for test production during the summer half in a period with a possible excess of shuttle tankers.

In connection with, or in addition to the above-mentioned fields of use, the system according to the invention will be suitable for use in connection with water injection, water purification plants, well stimulation, pumping of oil from ship wrecks located on the sea bed, etc. The system also is suitable for use in waters having floating ice and icebergs, the system when required making possible a quick disconnection, without any risk for damage of the submerged buoy.

The invention will be further described below in connection with exemplary embodiments with reference to the drawings, wherein

Fig. 1 shows a view of a vessel and a submerged buoy forming part of the system according to the invention;

Fig. 2 corresponds to Fig. 1, but shows the buoy raised and introduced in the receiving space of the vessel;

Fig. 3 is a schematic sectional view illustrating an embodiment of the total system according to the invention;

5 Figs. 4-6 show different stages during installation of the system;

Fig. 7 is a schematic sectional view illustrating release of riser couplings in the system;

10 Fig. 8 is a schematic sectional view corresponding to Fig. 3, but showing an advantageous embodiment in connection with the buoy's lead-through arrangement for transfer lines;

Fig. 9 shows a partial section along the line IX-IX in Fig. 8;

15 Fig. 10 shows an enlarged view of the detail B in Fig. 8;

Fig. 11 shows the system in Fig. 8 during pulling-up of transfer lines;

Fig. 12 shows a schematic sectional view of the buoy in the embodiment according to Fig. 8 in disconnected condition; and

20 Fig. 13 shows embodiments of locking and sealing means in the receiving space of the vessel.

Corresponding members and elements are designated by the same reference numerals in the different drawing Figures.

In Fig. 1 there is shown a submerged buoy 1 which is anchored to the sea or ocean bed 2 by means of a suitable mooring system consisting of a number of anchor lines 3 and floating bodies 4, so that the buoy floats at a predetermined desired depth below the water surface 5, the buoyancy of the buoy then being in equilibrium with the weight of the mooring system. A flexible transfer line 6 extends between the buoy 1 and a production well 7 at the sea bed. Even if only one line 6 is shown, there may in practice be arranged several lines in the form of one or more flexible risers (for production, injection, etc.) and an associated umbilical cable.

35 A vessel 8 in its bow portion is provided with a receiving space 9 and is brought into position with the receiving space located above the buoy 1. The vessel may be a shuttle tanker which is equipped as a production vessel and which for this purpose will be provided with a modularized, deck-mounted

processing plant and a burner means ("flare"). In preparation for production the buoy 1 is hoisted up and fastened in the receiving space 9, as shown in Fig. 2.

A schematic sectional view of an embodiment of the system according to the invention is shown in Fig. 3 which shows the constituent parts quite schematically, and without correct relative proportions. The system may be installed in a suitably modified shuttle tanker of the implementation shown in the aforementioned international patent application No. PCT/NO92/00055, and thus be installed in the bow portion of such a vessel, as suggested in the Figure.

The vessel 8 includes a submerged receiving space 9 and a shaft 10 extending between the receiving space and the deck 11 of the vessel. A buoy 1 is introduced in the receiving space 9 and mechanically locked by locking means 12. The buoy comprises an outer buoyancy member 13 which is arranged for releasable locking in the receiving space by means of the locking means 12, and a central member 14 which is rotatably mounted in the outer member 13 and is anchored to the sea bed by means of the anchor lines 3. The fundamental construction and manner of operation of the buoy in essential features corresponds to what is disclosed in the aforementioned international patent application No. PCT/NO92/00056, and reference is made to this application for a further description of the general buoy structure.

In the present system the buoy is, however, modified in relation to the buoy according to the prior application, the flexible transfer lines extending between the buoy and the production well at the sea bed in the present case being brought directly through the central member of the buoy, in order to be pulled up to the region of a swivel unit 15 arranged at the deck of the vessel. In the embodiment shown in Fig. 3 the central member 14 of the buoy is provided with a pair of lead-through passages 16 for penetration of a pair of flexible risers 17, the buoy at the underside being provided with buoy stiffeners 18 at the outlet of the lead-through passages. In practice the buoy may be provided with a number of lead-through passages corresponding to the topical number of transfer lines, e.g. one riser for production, one riser for injection, an umbilical cable for hydraulic and signal lines, etc.

The swivel unit 15 arranged at deck level, and more specifically on a superstructure 19, consists of a stack of swivels of a suitable type for the topical production case. In the Figure there is shown a pair of high pressure production 5 swivels 20 and 21, whereas in practice there will normally also be provided a hydraulic swivel and a service line swivel. The shown swivels are of conventional construction, and each consists of inner and outer mutually rotatable swivel members defining an annulus therebetween, the inner swivel member having a tube 10 connection communicating with the annulus and with a coupling unit for connection to an associated transfer line from the buoy, and the outer swivel member having a tube connection communicating with the annulus and with a tube system leading to the process plant of the vessel. In Fig. 3, the swivel members of the 15 swivel 20 are designated 20' and 20", both tube connections of the inner swivel members are designated 22, the tube connections of the outer swivel members are designated 23, and the tubes leading to the processing plant (not shown) of the vessel are designated 24.

20 An essential part of the system according to the invention is a holding cylinder 30 extending through the shaft 10 and being non-rotatably connected between the inner member of the swivel unit 15 and the inner or central member 14 of the buoy. This cylinder has as its main task to keep the inner member of 25 the swivel unit 15 stationary relative to the central member 14 of the submerged buoy. The cylinder is supported radially by means of a radial bearing 31, and axially by means of an axial bearing 32 placed under the swivel unit 15. The upper end of the cylinder is fastened, e.g. bolted, to the inner swivel member 30 20', and its lower end is non-rotatably connected to the central buoy member 14 through a cogging 33 shown in connection with the detail A in Fig. 3. In operation the central buoy member 14 is kept in position by the anchor lines 3, and the holding cylinder 35 keeps the inner swivel member stationary relative to the central buoy member, said cogging absorbing the torque transferred to the holding cylinder - because of friction in the swivel unit - when the outer swivel member is turned with turning of the vessel.

A drive mechanism 34 to cause the outer member of the

swivel unit to turn with the vessel is shown to be arranged next to the swivel unit 15.

The flexible risers which are carried through the buoy 1, is carried internally of the holding cylinder 30, the risers 5 with their upper end portions being carried through and fastened to a collar 35 which is slidable along the inner wall of the cylinder 30. In Fig. 3 the collar is shown in its operating position wherein the risers are connected to the tube connections 22 of the swivel unit 15 through a coupling unit which on the 10 whole is designated by the reference numeral 36. The collar 35 is in the form of a plate which is suitably perforated (in a manner not further shown), to obtain an optimal braking of the downward movement of the collar in sea water in the lower part of the holding cylinder 30 when disconnecting the buoy 1 from the 15 vessel, as described later, in order to get a minimized shock load from the collar against the buoy. The collar is also shown to be provided with damping springs 37 at the underside, to minimize the shock load.

The coupling unit 36 i.a. is shown to comprise a quick 20 release coupling 38 for each line connection, and in addition valves 39, 40, which possibly may be automatic shut off valves, are provided above as well as under the quick release coupling, in order to limit spill of hydrocarbons and make possible a disconnection when the tubes are under pressure. Further, in 25 connection with the coupling unit 36, there is provided a hang-off collar 41 by means of which the coupling unit may be suspended in the holding cylinder by means of a projection means 42 on the inner wall of the cylinder 30.

When installing the system, it will be necessary to 30 turn the holding cylinder 30 so that its lower cogging 33 matches into the cogging of the central member 14 of the buoy, when the buoy is locked in the receiving space 9. For this purpose there is provided an electric motor 41 in combination with a gear rim 44 on the cylinder.

In order to damp pressure shocks in the cylinder 30 35 when disconnecting the buoy and the flexible risers, the lower part of the cylinder is provided with suitable perforations 45. At the level of the quick release couplings 38 the cylinder advantageously is provided with openings (not shown) for access

and natural ventilation.

Different stages in installation of the system according to the invention will be described below with reference to Figs. 4-6.

As an introductory operation, the buoy 1 is pulled into the receiving space 9 of the vessel, a pull-in line 46 attached to the buoy (see Fig. 4) being pulled in by means of a winch device (not shown) on the vessel 8. The pull-in procedure may be carried out as described in the international patent application No. PCT/NO92/00053. When the buoy has been pulled in, the holding cylinder 30 is turned by means of the motor 43 until the lower cogging 33 of the cylinder matches with the corresponding cogging on the buoy (see Fig. 3). A video camera (not shown) which is used for the pull-in and locking operation, will give information as to how the holding cylinder 30 has to be turned in order for the cogging 33 to be thrown into mesh. Thereafter the buoy is locked in place by the locking means 12, and the non-rotatable connection between the buoy and the holding cylinder is established. The lower part of the shaft 10 and the cylinder 30 now will be filled with water, up to a level corresponding to the draught of the vessel. This water quantity may remain in the shaft, or it can - if desired - be removed by means of suitable pumping equipment, provided that the buoy forms a sealing connection with the receiving space.

When the buoy is locked in the receiving space, the pull-in line 46 is disengaged from the central member 14 of the buoy by means of a drop weight, so that the fastening for this line is transferred to the collar 35. Thereafter the collar 35 with the risers 17 are pulled up through the holding cylinder 30 by means of the pull-in line 46, up to the upper end of the cylinder on a level with the axial bearing 32 of the cylinder, where the collar is locked axially by a suitable means, in the position shown in Fig. 5. The pull-in line 46 thereafter is loosened from the collar 35 and instead affixed to the hang-off collar 41 of the coupling unit 36, and the coupling unit thereafter is hoisted in place and lowered above the collar 35, whereafter it is mounted to the end terminations of the risers 17. Thereafter the axial locking of the collar 35 is released, and the risers 17 and the coupling unit 36 are lowered so much

that the hang-off collar 41 comes to rest against the projection means 42 on the inner wall of the holding cylinder. The situation then is as shown in Fig. 6.

The next operation is to assemble the swivel unit 15 with associated tube connections and the drive mechanism 34 at the top of the axial bearing for the holding cylinder. When the swivel unit is lowered in place, the tube connections 22 are flanged to the top of the tubes from the quick release couplings 38, and the tube connections 23 are connected to the tubes 24.

When the buoy and the associated risers are to be disconnected from the vessel, this takes place sequentially, as illustrated in Fig. 7. Firstly, the quick release couplings 38 are released, possibly after the valves 39 and 40 firstly having been shut off, if these are not automatic shut off valves. As shown in Fig. 7, a holding line 47 is fixed to the collar 35, which line goes via a pulley 48 to a winch (not shown) having a constant braking moment. This is done in order to avoid compression and deflection of the flexible risers 17 under the weight of the collar and the disengaged elements resting thereon after release of the quick release couplings. The perforated collar 35 with the risers then is lowered in a controlled manner to the water surface, whereafter it is braked by the water in the holding cylinder 30, so that it becomes lying at the top of the buoy, without any shock loading of importance. The locking means 12 for locking of the buoy are released with a time delay which is sufficient for the collar 35 to rest on the buoy when release takes place. When the buoy is disengaged, it sinks down clear of the vessel, because of its weight and the pulling forces from the mooring and riser systems.

Figs. 8-12 show another embodiment of the system according to the invention, and especially an advantageous embodiment with respect to the buoy's lead-through means for transfer lines which also here are in the form of flexible risers.

As appears from Fig. 8, the schematically shown buoy 50 here comprises an inner cylinder 51 which by means of an outwardly projecting collar 52 is suspended in a central passage 49 in the central member 53 of the buoy. The cylinder 51 has a bottom 54 which is provided with a central opening 55 and with

a number of recesses 56 extending radially outwardly from the opening 55 and being intended for reception of respective risers 17 (see Fig. 9). The central opening 55 is covered by a lid 57 which is fixed to the bottom of the cylinder 51 by means of a suitable bolting arrangement.

The risers 17 at the bottom of the buoy are surrounded by buoy stiffeners 58 which are fastened to the bottom 54 of the cylinder 51 and the lid 57 by means of suitable bolts 59, as shown in the enlarged segment in Fig. 10 (the detail B in Fig. 8). The risers 17 are surrounded by gaskets 60 to prevent ingress of sea water around the risers and the buoy stiffeners.

As will be seen, the inner cylinder 51 may be lifted up from or lowered into the central member 53 of the buoy 50. Thus, the inner cylinder may be pulled up from the buoy when this is introduced into and secured in the receiving space 9 of the topical vessel, so that one may carry out dry bolting of the buoy stiffeners 58 to the bottom of the inner cylinder and assembly of the gasket means around the risers. The central opening 55 in the bottom of the cylinder makes possible a pulling-up of riser end terminations with a larger transverse dimension than the recesses 56.

In order to provide space for pulling-up of the inner cylinder 51, the lower end of the holding cylinder 30 is provided with a telescopically displaceable cylinder part 61 which, in the illustrated embodiment, can be raised and lowered by means of hydraulic cylinders 62. The cylinder part 61 possibly may be connected to the inner cylinder 51 for lifting and lowering thereof. Further, between the telescopically displaceable cylinder part 61 and the fixed part 63 of the holding cylinder 30, there are provided axial guides 64 for the transfer of torque from the swivel unit 15 to the buoy 50 (introduced by the radial bearing of the holding cylinder 30 and the swivel).

Pulling-up and installation of flexible risers will be described with reference to Fig. 11.

During this operation the vessel in question is ballasted so much that the water line level is located somewhat below the top of the conical receiving space 9. The inner cylinder 51 and the telescopic part 61 of the holding cylinder are pulled up so much that the bottom of the inner cylinder is

located on a level with the upper edge of the central member 53 of the buoy. A riser 17 with an associated buoy stiffener 58, which by means of steel ropes 65 is fastened to an end termination 66, is pulled into the holding cylinder 30 by means of a pull-in line 67 and a winch (not shown) at deck level. When the buoy stiffener flange is on a level with the lower edge of the bottom 54 of the inner cylinder 51, the riser 17 is pulled out into one of the recesses 56 in the bottom and locked in this position. The flexible risers are pulled in by turns. The lid 57 thereafter is bolted over the central opening of the bottom, and the buoy stiffeners 58 are bolted to the lid and the bottom of the inner cylinder. The inner cylinder 51 and the telescopic part 61 are lowered down, and the inner cylinder is hung off on the central member 53 of the buoy. A cogging 68 at the lower end of the telescopic part 61 is meshed with the corresponding cogging 69 on the central member 53 of the buoy.

Disconnection of the buoy 50 with associated risers 17 and anchor lines 3 will be described with reference to Fig. 12.

When disconnecting the buoy, the riser couplings 36 (see Fig. 3) are released, and the risers 17 together with the riser-enclosing collar 35 and the associated part of the riser couplings are lowered down until the collar 35 is hung off on the inner collar 70 arranged on the inner wall of the inner cylinder 51. For the lowering there is used a winch (not shown) which is placed at the deck of the vessel, the holding line (not shown) of the vessel being fastened to the collar 35. The winch is controlled by a PLS control unit providing for a controlled lowering. A shutter 71 is bolted to the top of the inner cylinder 51 for i.a. protecting the gasket surfaces and valves of the riser couplings.

As shown in Fig. 12, the submerged buoy 50 with risers and anchor system may be located by means of a floating buoy 72 which is connected to the buoy 50 via a line 73, for coupling to the vessel of interest. Disconnection of the buoy 50 may e.g. take place in connection with classification of the vessel.

An embodiment of the device for releasable fastening of the buoy in the receiving space of the vessel is shown in Fig. 13. The illustrated device comprises a number of locking segments 81 for connecting an upper collar member 82 of the buoy to a

downwards projecting, mating collar member 83 arranged around the upper opening of the receiving space of the vessel, and a locking ring 84 surrounding the segments 81 and being raisable and lowerable by means of hydraulic jacks or cylinders 85. As shown, 5 the segments 81 are supported by the collar member 83 of the receiving space and are designed for cooperation with the locking ring 84, so as to be brought to their locking position with lowering of the locking ring 84, and to a release position with raising of the locking ring. As appears from the Figure, said 10 collar members 82, 83 are shaped with conical surfaces to which the locking segments 81 are adapted, and the segments and the locking ring further are shaped with surfaces which are self-locking. In addition, the hydraulic cylinders 85 have locking of their piston rods, so that a double locking is obtained.

15 The receiving space in Fig. 13 is shown to include a lower conical part 86 and an upper cylindrical part 87 having a cylindrical inner wall 88. In the lower portion of the cylindrical inner wall 88 there is arranged an axially displaceable ring 89 which is in sealing abutment against the inner wall of 20 the receiving space by means of a sealing ring 90, and which may be displaced along the inner wall by means of suitable actuators 91, e.g. hydraulic cylinders. At its underside the ring 89 is provided with an additional sealing ring or gasket 92 which, with displacement of the ring 89, can be brought into sealing 25 engagement with a corresponding sealing surface 93 on the outer member of the buoy. In this manner one obtains a safe sealing against leakage of sea water between the buoy and the inner wall of the receiving space.

P a t e n t c l a i m s

1. A system for use in offshore oil and gas production
5 from production wells on the sea bed, comprising a submerged buoy
(1) having an outer buoyancy member (13) which is arranged for
introduction and releasable fastening in a submerged, downwardly
open receiving space (9) in a vessel (8), and a central member
(14) which is rotatably mounted in the outer member (13) and is
10 anchored to the sea bed (2) and is connected to at least one
transfer line (6) extending from a respective production well (7)
up to the buoy (1), a shaft (10) extending between the receiving
space (9) and the deck (11) of the vessel (8), **CHARACTERIZED IN**
that it comprises a swivel unit (15) which is arranged at deck
15 level of the vessel (8) and which comprises inner and outer
mutually rotatable swivel members (20', 20") and with the inner
swivel member is rigidly connected to a holding cylinder (30)
which extends downwards through the shaft (10) and with its lower
end is arranged for non-rotatable connection with the central
20 member (14) of the buoy (1), and that the central member (14) of
the buoy is provided with a lead-through means (16) for the
topical number of transfer lines (17), so that these can be
pulled up through the buoy and inside of the holding cylinder
(30) up to the swivel unit (15), these lines (17) at their upper
25 ends being arranged for connection with associated conduit
connections (22) which are connected through the swivel unit (15)
to a tube system (24) on the vessel (8).

2. A system according to claim 1, **CHARACTERIZED IN** that
the upper end portions of the transfer lines (17) are carried
30 through and fastened to a collar (35) which is slidable along the
inner wall of the holding cylinder (30).

3. A system according to claim 2, **CHARACTERIZED IN** that
the collar (35) consists of a plate which is perforated for
suitable braking of the downward movement of the collar in sea
35 water in the holding cylinder (30) in case of disconnection of
the buoy (1) from the vessel (8).

4. A system according to claim 2 or 3, **CHARACTERIZED IN**
that damping springs (37) are arranged at the underside of the
collar (35).

5. A system according to any of the claims 2-4, CHARACTERIZED IN that the central member (14) of the buoy is provided with a means allowing automatic release of a pull-in line (46) for the buoy (1) by means of a drop weight, so that the fastening for the line (46) is transferred to the collar (35).

6. A system according to any of the claims 2-5, CHARACTERIZED IN that the transfer lines (17) and the associated line connections (22) of the swivel unit (15) are interconnected by means of quick release couplings (38).

10 7. A system according to claim 6, CHARACTERIZED IN that automatic shut off valves (39, 40) are arranged on the transfer lines (17) above and below the quick release couplings (38).

8. A system according to any of the preceding claims, CHARACTERIZED IN that the holding cylinder (30) is supported by means of a lower radial bearing (31) and an upper axial bearing (32).

9. A system according to any of the preceding claims, CHARACTERIZED IN that the wall of the holding cylinder (30) is perforated (45) at the lower end of the cylinder.

20 10. A system according to any of the preceding claims, CHARACTERIZED IN that the lower end of the holding cylinder (30) is rigidly connected to the central member (14) of the buoy (1) through a cogging (33).

11. A system according to any of the preceding claims, 25 CHARACTERIZED IN that the lead-through means of the buoy comprises an inner cylinder which is arranged to be suspended in a central passage in the central member of the buoy, and to be lifted from or lowered into the central member, the cylinder having a bottom which is provided with a central opening and with 30 radial recesses from the opening, for reception of respective transfer lines.

12. A system according to claim 11, CHARACTERIZED IN that the top of the receiving space (9) of the vessel is arranged with such a height that, with suitable ballasting of the vessel 35 (8), it will be located above the still water level, to enable dry installation of transfer lines (17) with lifted inner cylinder (51).

13. A system according to claim 11 or 12, CHARACTERIZED IN that the transfer lines are carried in a sealing manner

through respective buoy stiffeners which are adapted to be fastened to the bottom of the inner cylinder in the associated recesses, and to a lid covering the central opening of the bottom.

5 14. A system according to claim 11, 12 or 13, CHARACTERIZED IN that the lower end of the holding cylinder comprises a telescopically displaceable cylinder part which may be raised and lowered by means of hydraulic cylinders, and which can be connected to the inner cylinder of the buoy for raising and
10 lowering thereof.

15 15. A system according to claim 14, CHARACTERIZED IN that axial guides for transfer of torque from the swivel unit to the buoy are arranged between the telescopically displaceable part and the fixed part of the holding cylinder.

16. A system according to claim 2 and one of the claims 11-15, CHARACTERIZED IN that the inner cylinder is provided with an inner collar for support of the transfer-line enclosing collar in case of disconnection of the transfer lines from the swivel unit.

20 17. A system according to any of the preceding claims, CHARACTERIZED IN that a device for the releasable fastening of the buoy in the receiving space of the vessel comprises a number of locking segments for connection of an upper collar member of the buoy to a downwards projecting, mating collar member arranged
25 at the upper opening of the receiving space, and a locking ring enclosing the segments and being raisable and lowerable by means of hydraulic cylinders, the segments being supported by the downwards projecting collar member and being shaped for cooperation with the locking ring, so as to be brought to their locking
30 position with lowering of the locking ring, and to a release position with raising of the locking ring.

18. A system according to any of the preceding claims, wherein an upper part of the receiving space has a cylindrical inner wall, CHARACTERIZED IN that, in the lower portion of the
35 cylindrical inner wall, there is arranged an axially displaceable ring which is in sealing abutment against the inner wall and at its underside is provided with a sealing ring for sealing engagement with a corresponding sealing surface on the outer member of the buoy.

1/11

Fig. 1.

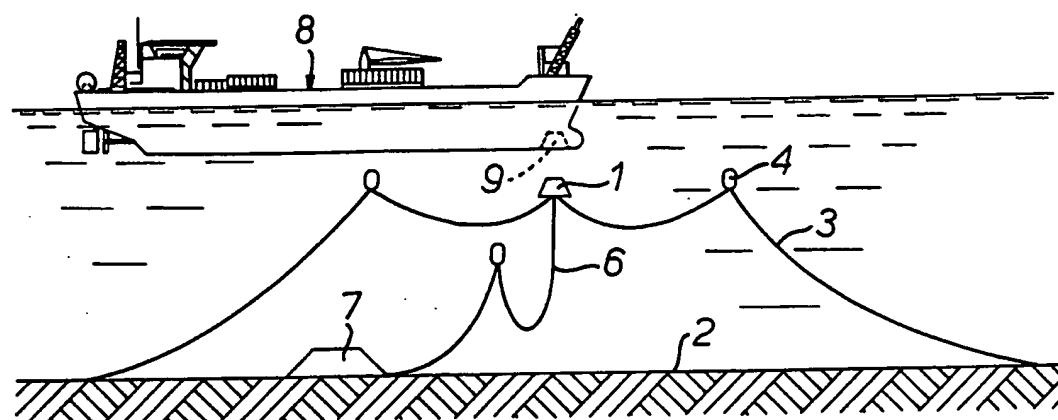
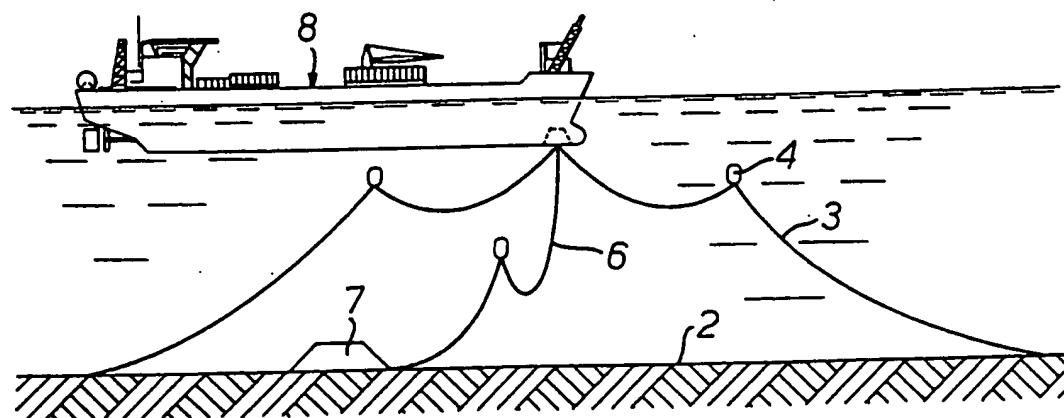
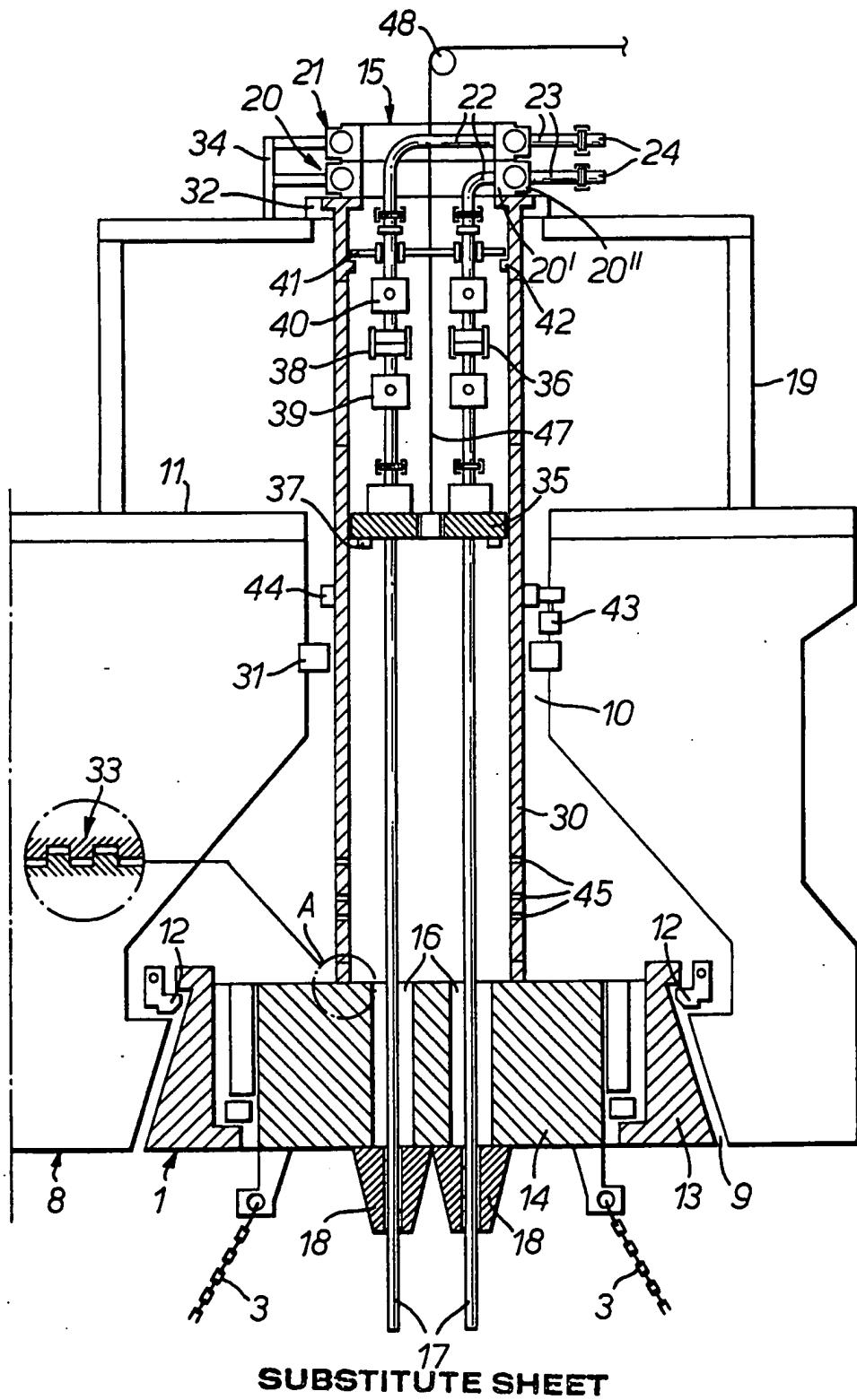


Fig. 2.

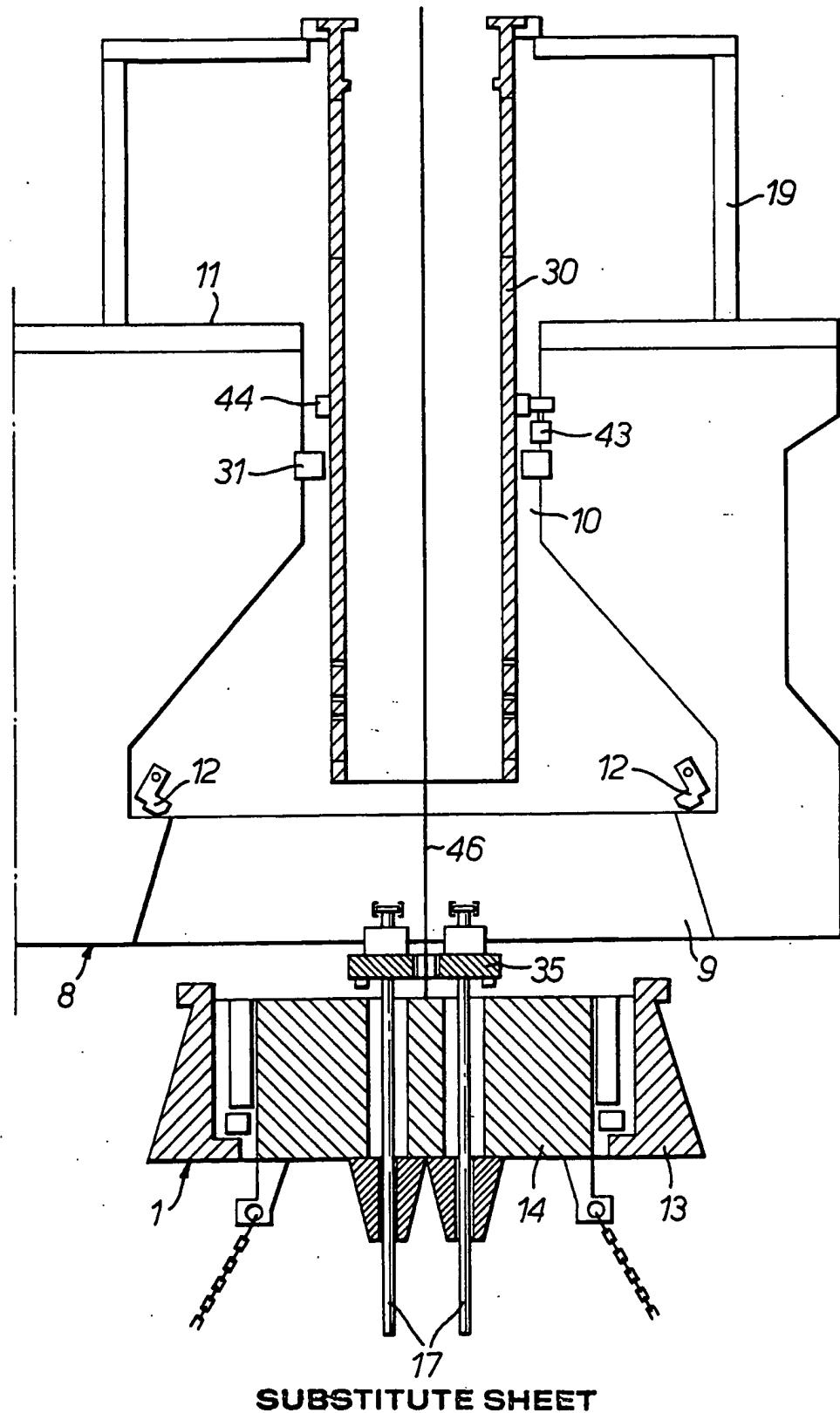


2/11

Fig. 3.

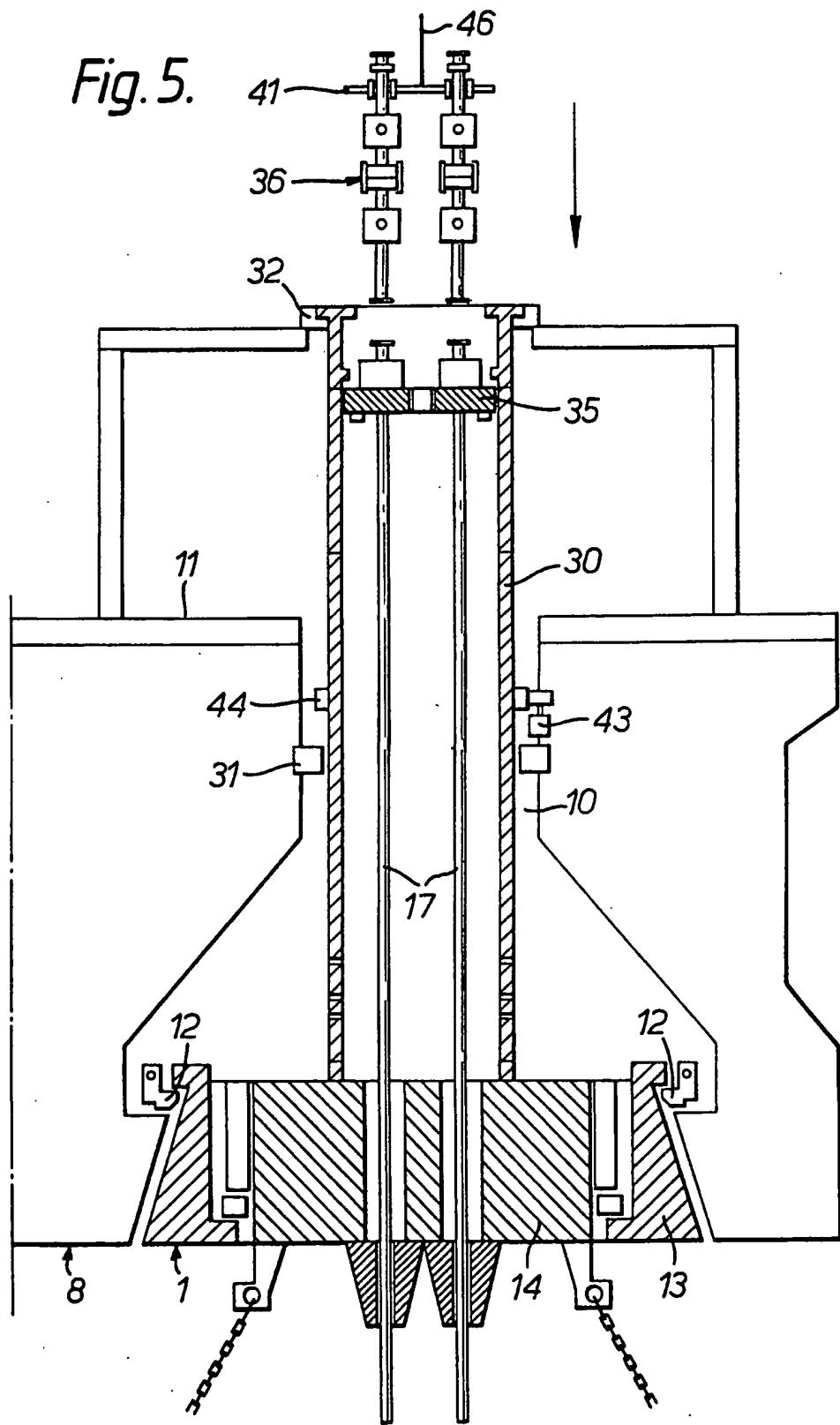


3/11
Fig.4.



4/11

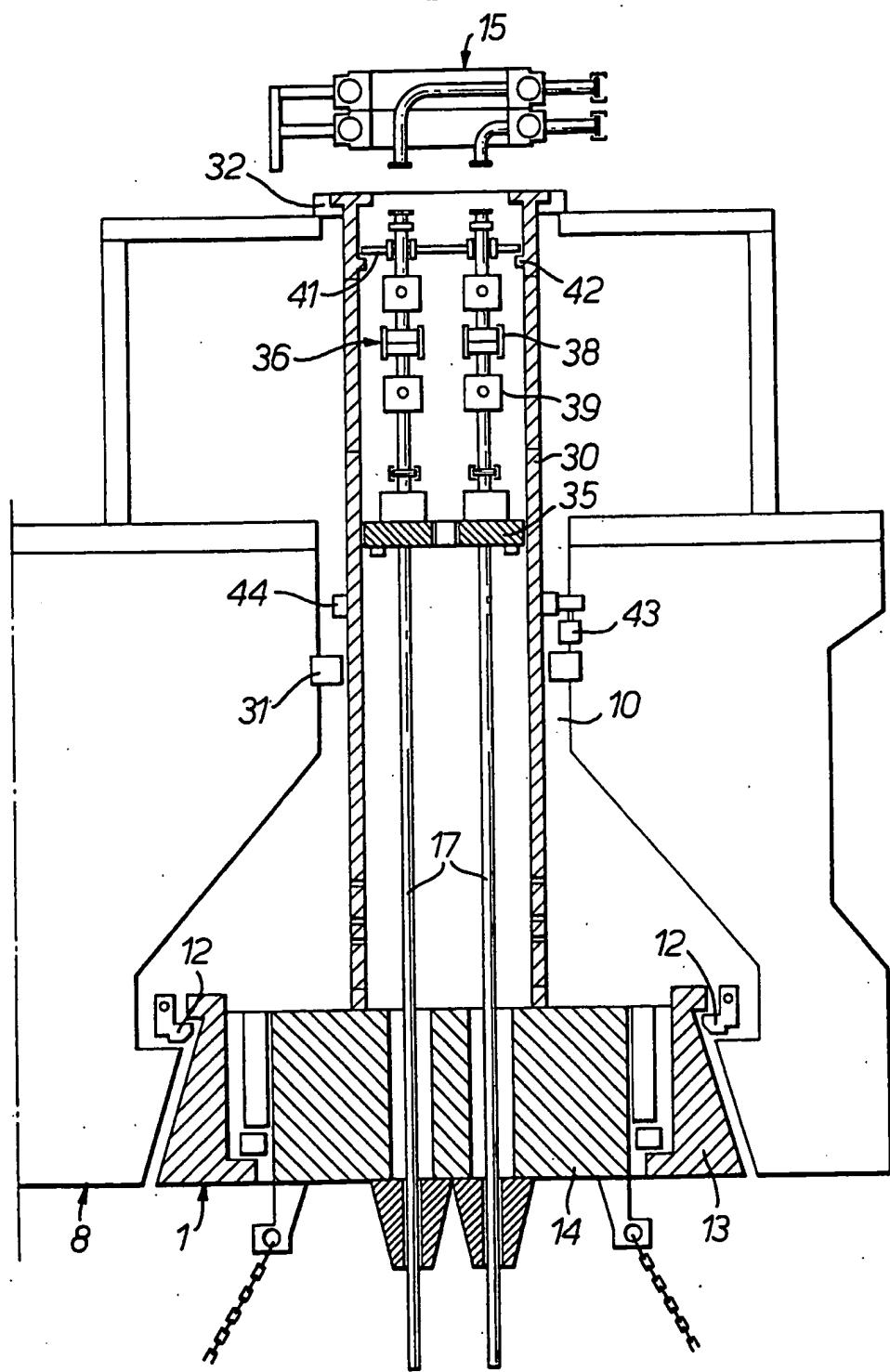
Fig. 5.



SUBSTITUTE SHEET

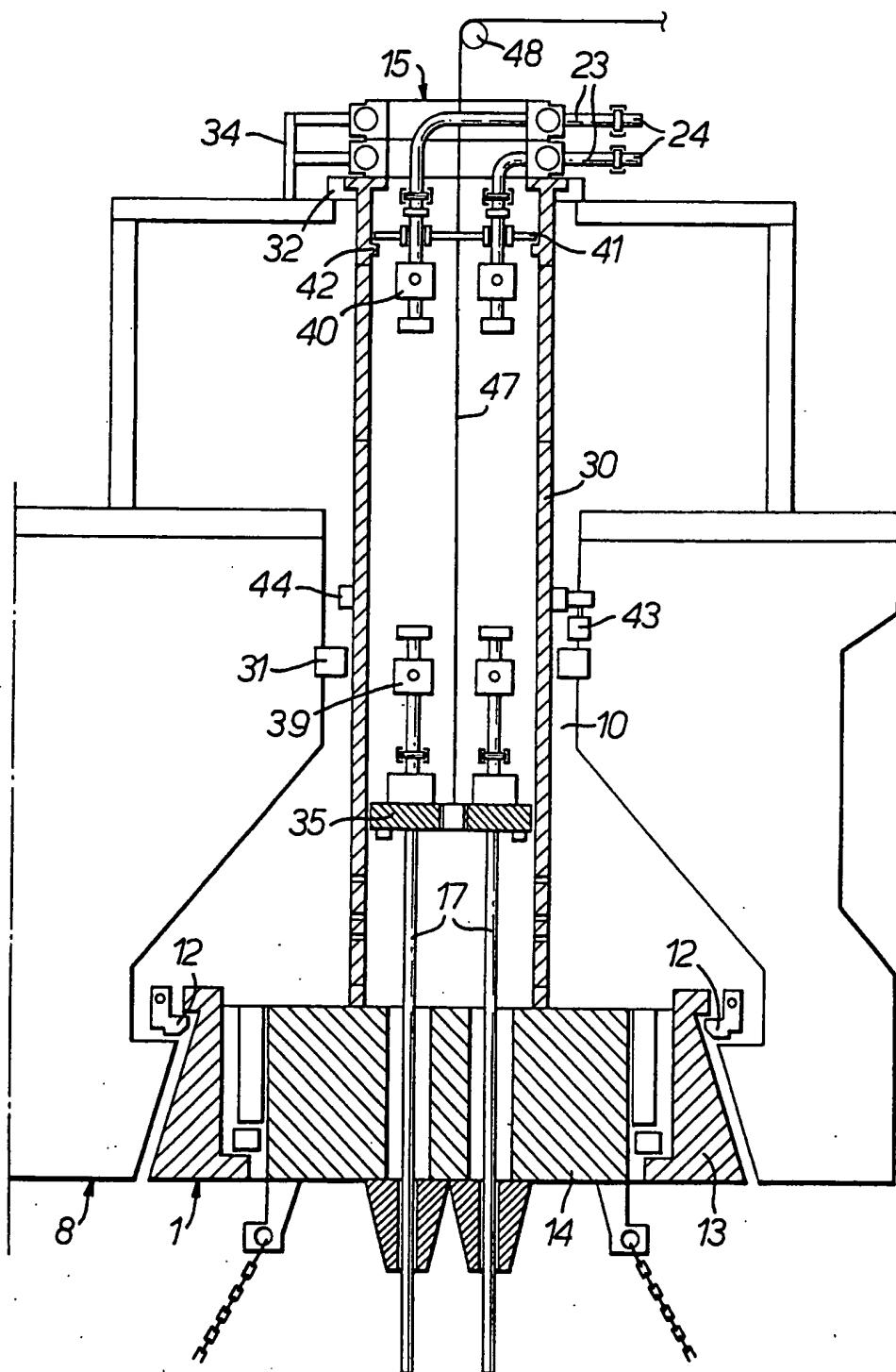
5/11

Fig. 6.



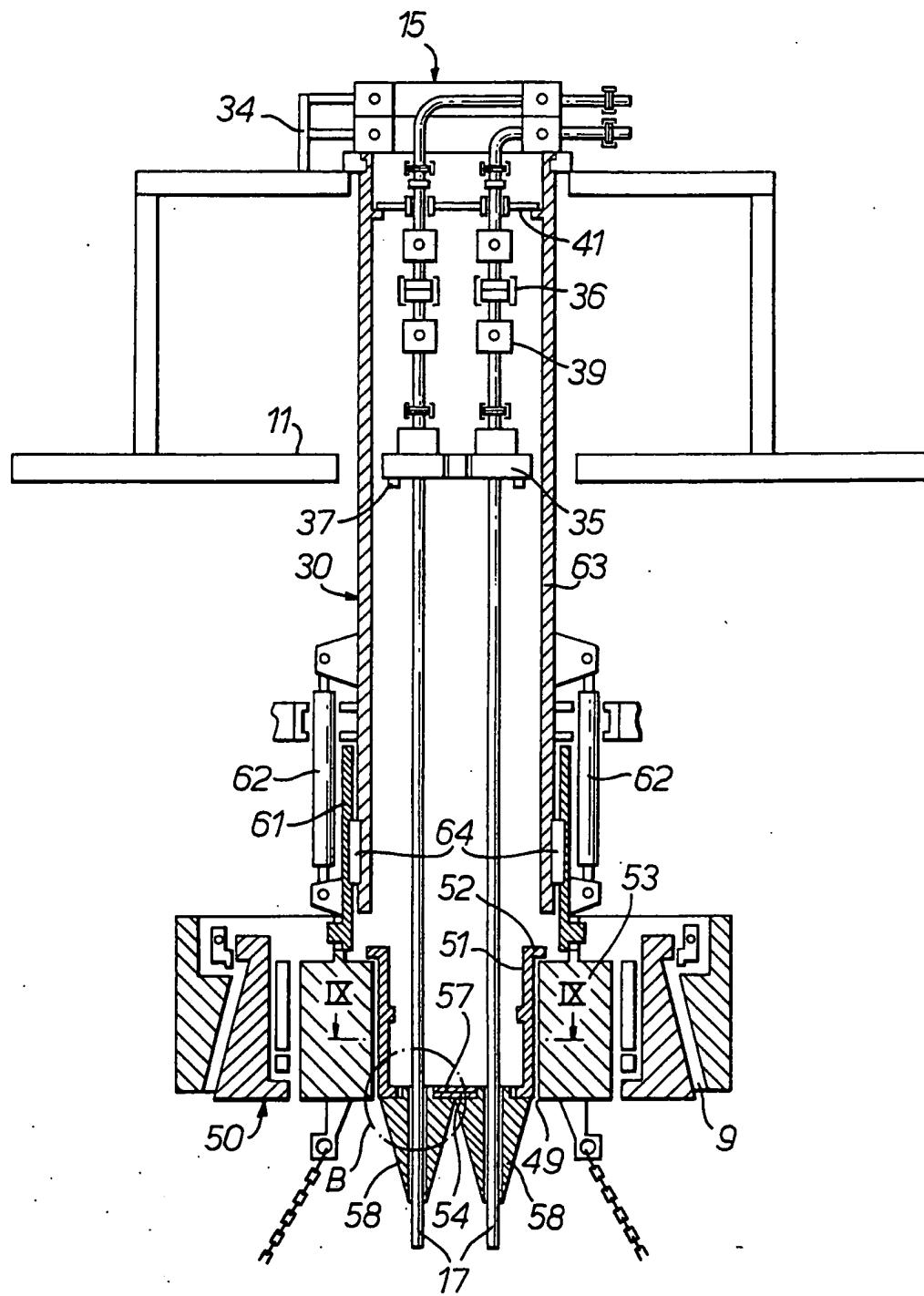
6/11

Fig. 7.

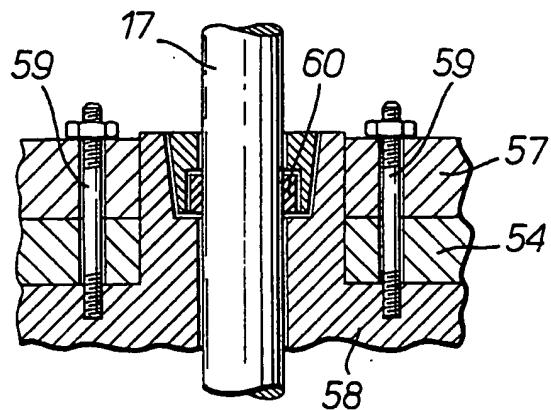
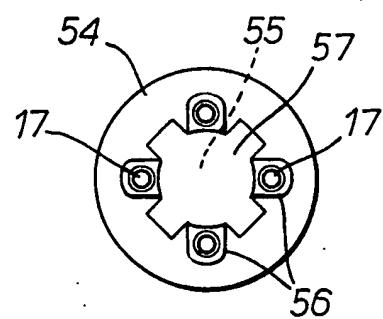


7/11

Fig. 8.

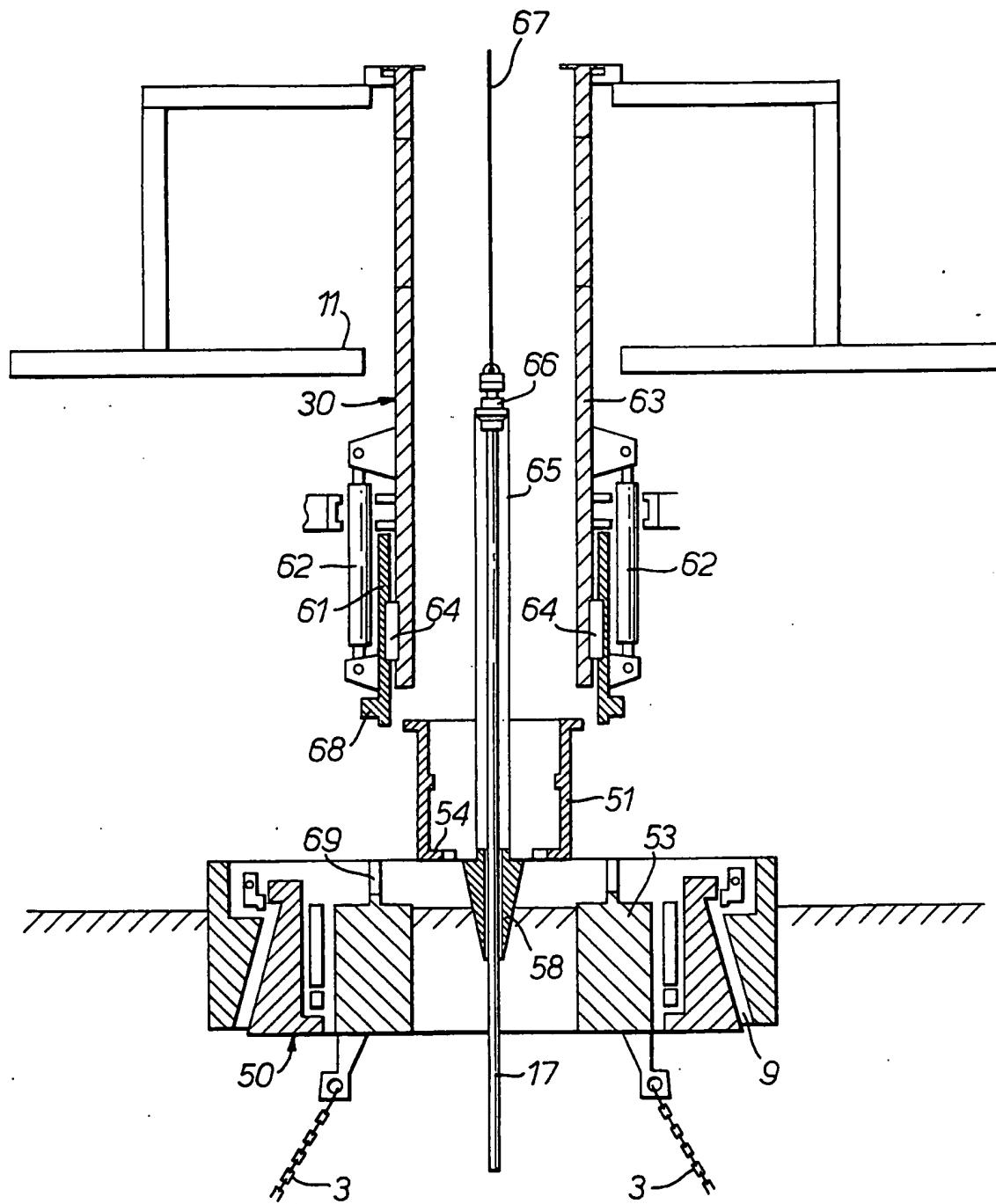


8/11

Fig. 10.*Fig. 9.*

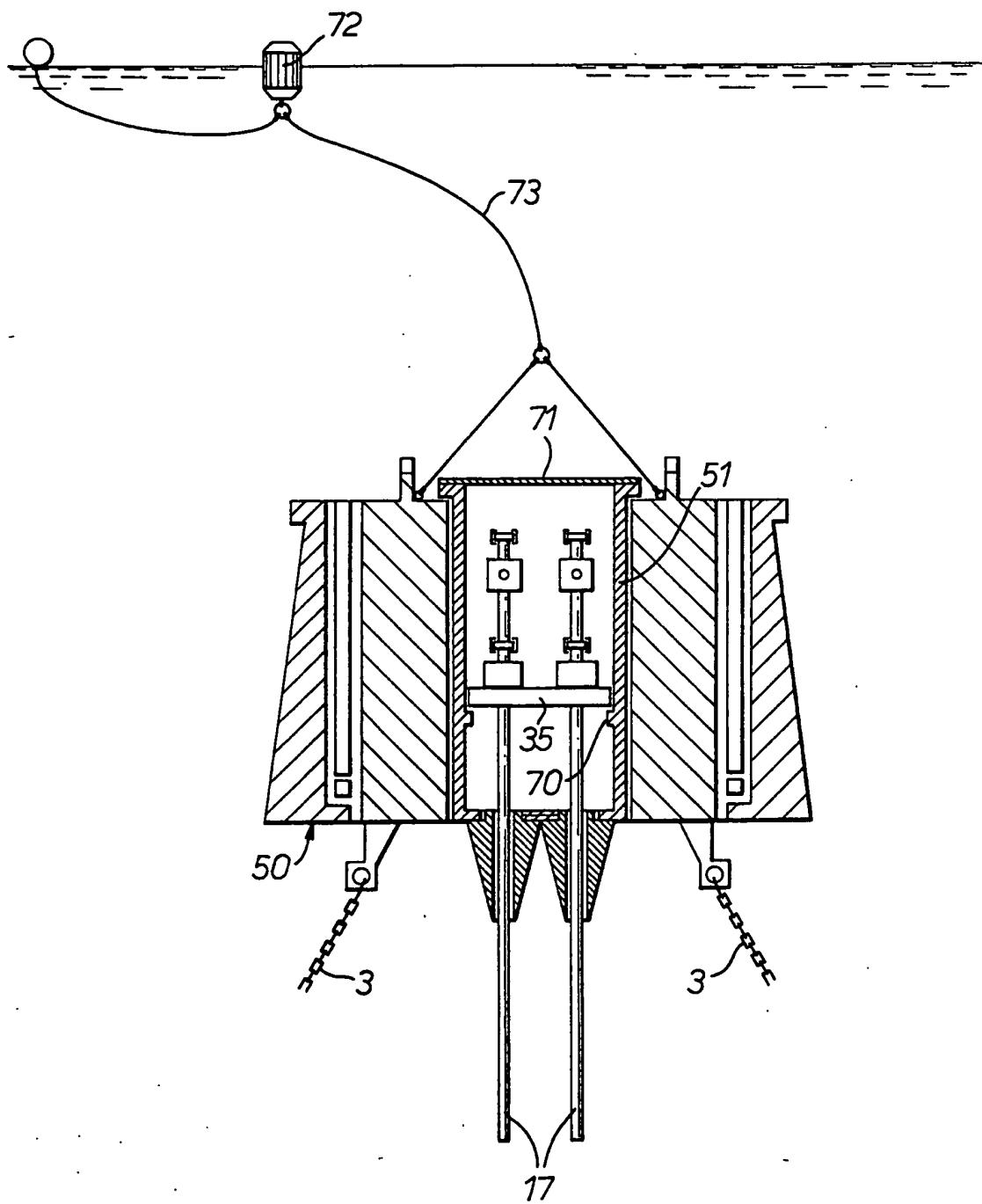
9/11

Fig. 11.

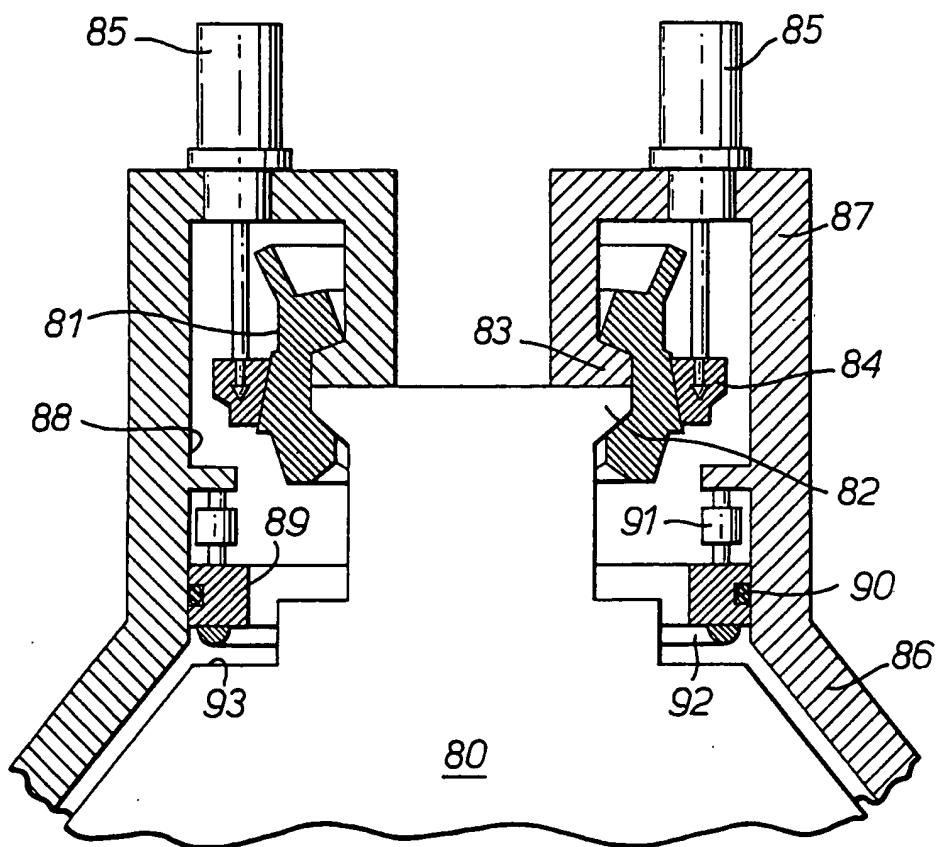


10/11

Fig.12.

**SUBSTITUTE SHEET**

11/11

Fig. 13.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 93/00082

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: E21B 43/01, B63B 21/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: E21B, B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NO, B, 160294 (MOBIL OIL CORPORATION), 27 December 1988 (27.12.88) --	1-18
A	NO, B, 164968 (BLOHN + VOSS AG), 27 August 1990 (27.08.90) --	1-18
A	NO, B, 167906 (EXXON PRODUCTION RESEARCH COMPANY), 16 Sept 1991 (16.09.91) --	1-18
A	SE, B, 457208 (GÖTAVERKEN ARENDAL AB), 5 December 1988 (05.12.88) -- -----	1-18

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *B* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed
- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *&* document member of the same patent family

Date of the actual completion of the international search

27 August 1993

Date of mailing of the international search report

31 -08- 1993

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Christer Bäcknert
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/07/93

International application No.

PCT/NO 93/00082

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
NO-B- 160294	27/12/88	NONE		
NO-B- 164968	27/08/90	NONE		
NO-B- 167906	16/09/91	NONE		
SE-B- 457208	05/12/88	CA-A- 1242894 FR-A- 2575786 GB-A,B- 2162799 SE-A- 8404011 US-A- 4660496	11/10/88 11/07/86 12/02/86 09/02/86 28/04/87	

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.